

CLAIMS

1. A process for the removal of contaminants from a surface of a substrate requiring precision cleaning, comprising the steps of: a) applying at least one fluid to the substrate surface, the fluid selected from the group consisting of a high vapor pressure liquid, a reactive gas, and of a reactive liquid; and b) cryogenically cleaning the surface of the substrate.
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2. The process of claim 1 wherein steps a) and b) are carried out simultaneously.
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3. The process of claim 1 wherein steps a) and b) are carried out sequentially.
4. The process of claim 1 wherein the at least one fluid is a high vapor pressure liquid selected from the group consisting of ethanol, acetone, ethanol-acetone mixtures, isopropyl alcohol, methanol, methyl formate, methyl iodide, ethyl bromide, acetonitrile, ethyl chloride, pyrrolidine, tetrahydrofuran and mixtures thereof.
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5. The process of claim 1 wherein the at least one fluid is a vapor of a reactive liquid selected from the group of liquids consisting of ethanol, acetone, ethanol-acetone mixtures, isopropyl alcohol, methanol, methyl formate, methyl iodide, ethyl bromide, and mixtures thereof.
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6. The process of claim 1 wherein the at least one fluid is a reactive gas selected from one or more of the group consisting of ozone, water vapor, hydrogen, nitrogen, nitrogen oxides, nitrogen trifluoride, helium, argon, neon, sulfur trioxide, oxygen, fluorine, fluorocarbon gases and mixtures thereof.
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7. The process of claim 1 wherein the at least one fluid is a reactive gas or vapor selected from the group consisting of isopropyl alcohol, ethanol-acetone mixtures, methanol, ozone, water vapor, nitrogen trifluoride, sulfur trioxide, oxygen, fluorine and fluorocarbon gases, and mixtures thereof.
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8. The process of claim 1 wherein the fluid remains in contact with the surface for up to 10 minutes prior to the initiation of cryogenic cleaning.
- 5 9. The process of claim 8 wherein the fluid remains in contact with the surface for less than 2 minutes prior to the initiation of cryogenic cleaning.
10. The process of claim 1 wherein the contaminants are less than 0.76 μm in size.
- 10 11. The process of claim 1 wherein the contaminants are less than 0.13 μm in size.
12. The process of claim 1 wherein the high vapor pressure liquid has a vapor pressure greater than about 5 kPa at 25°C, and a freezing point below about -50°C.
- 15 13. The process of claim 1 wherein the high vapor pressure liquid has a dipole moment of greater than about 1.5 D.
14. The process of claim 1 wherein the high vapor pressure liquid remains on the surface in a layer of at least 5 \AA for less than 10 minutes and preferably less than 2 minutes prior to the initiation of cryogenic cleaning.
- 20 15. The process of claim 4 wherein the process includes the further step of the high vapor pressure liquid removing bulk water from the substrate surface.
16. The process of claim 1 wherein the substrate surface is a semiconductor, metal or dielectric film.
- 25 17. The process of claim 1 wherein the at least one fluid is a reactive gas or vapor which reacts with the contaminants on the surface to form a volatile gaseous byproduct; and further comprising the steps of maintaining the reactive gas or vapor in contact with the surface for up to 20 minutes, and removing the gaseous byproducts, prior to the initiation of cryogenic cleaning.
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18. The process of claim 17 wherein the reactive gas or vapor is introduced in a chamber containing the substrate, under low pressure and/or at temperatures of up to 200EC.

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19. The process of claim 18 wherein removing the byproducts comprises purging the chamber with nitrogen or Clean Dry Air.

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20. The process of claim 17 wherein the reactive gas or vapor is applied to the surface in the presence of a free radical initiator to generate reactive chemical byproducts from the reactive gas or vapour and the contaminants.

21. The process of claim 20 wherein the free radical initiator is ultraviolet light, x-ray, laser, corona discharge, or plasma.